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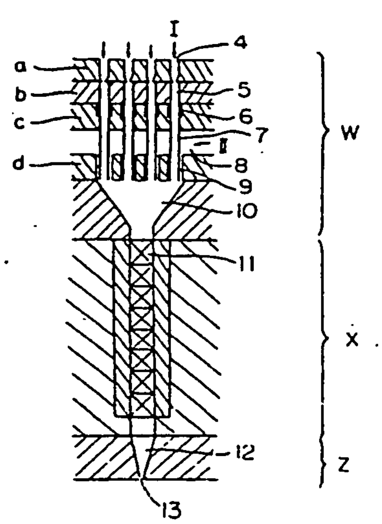
(54) **Spinneret assembly for multi-ingredient composite fibers.**

(57) A spinneret assembly for spinning multi-ingredient composite fibers, each of which has a large number of core ingredients finely dispersed in an intervening ingredient, includes at least three kinds of elements W, X and Z. A first element W has at least a composite stream forming region 10 in which two separately guided polymer streams I and II are joined, and channels (4, 5, 7) and (9) respectively for the two polymer streams I and II. A second element X has a stationary type dividing device 11. A third element Z has a converging portion 12 and a nozzle orifice 13 discharging the resultant composite stream to form a multi-ingredient composite fiber. From the fibers thus produced, extremely fine filaments are obtained by dissolving the ingredients other than core ingredients.

Fig. 5



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SPINNERET ASSEMBLY FOR MULTI-INGREDIENT COMPOSITE FIBERS

The present invention relates to a spinneret assembly for multi-ingredient composite fibers, more particularly to spinneret assembly suitable for producing synthetic fibers in which a plurality of ingredients are mixed in cross-section thereof.

In a known method for producing multi-ingredient composite fibers, i.e., "polymer blend" spinning or "mixed" spinning, beads or chips of two or more kinds of polymers are mixed and melted together and the molten mixture is spun to fibers through a normal spinneret assembly.

Though fine fibers of less than 0.01 denier may easily be obtained according to this method, it is very difficult to decide favorable spinning conditions under which smooth production can be carried out. Such conditions are affected by many factors, such as polymer viscosity, ratio of viscosity of each ingredient polymer, surface properties of the polymers, mixing ratio of the ingredients, degree of mixing, spinning temperature, dryness of the beads and chips, type of mixer, or configuration of nozzle orifices. Therefore, industrial production by the method is very troublesome.

Japanese Examined Patent Publication (Kokoku) No. 44-18369 discloses a composite spinning method advantageous for spinning stability. Theoretically, according to this prior art method, it is possible to spin multi-ingredient composite fibers having 5 or 100 or even 1,000 "islands" in cross-section by using a spinneret assembly having an increased number of pipes. Such a spinneret assembly however, results in

considerable difference in the discharging rate of the polymer between nozzle orifices thereof. This is because pressure exerted on the molten polymer in the spinneret assembly drops in accordance with the distance between the polymer inlet and nozzle orifices. This is especially serious in a multi-pipe type spinneret assembly, as a polymer stream of a first ingredient is obstructed by a plurality of parallelly disposed pipes for another polymer stream of a second ingredient, thereby accelerating the pressure drop. Further, since the space in the spinneret assembly occupied by the pipes is increased in accordance with the number of the pipes, the total size of the spinneret assembly must be enlarged. This further increases the pressure difference between the nozzle orifices. Accordingly, in order to achieve a stable spinning state by using this prior art method, it is necessary to minimize the number of pipes in the spinneret assembly.

Japanese Unexamined Patent Publication (Kokai) No. 54-125718, proposes another spinneret assembly by which "islands in sea" type composite fibers can be obtained with a lower number of pipes. Even by this assembly, however, it is difficult to produce a multi-ingredient composite fiber having an extremely finely divided core, from which extremely fine filaments can be obtained. Fibers obtained by this known apparatus have a plurality of core ingredients divided by another ingredient. The number of divisions is usually limited to 10 due to the structure of the spinneret assembly. This is because, if divided by more than 10, a divided polymer stream tends to join with an adjacent divided polymer stream after being conjugated with a polymer stream of another ingredient.

Accordingly, a strong demand exists for a spinneret assembly by which an "islands in sea" type multi-ingredient composite fiber having a very large

number of cores, e.g., more than 100 or 1000 and, in special case more than 10,000 or 100,000 can be obtained while keeping a stable spinning state.

It is an object of the invention to provide a spinneret assembly suitable for producing extremely fine fibers while keeping a stable spinning state.

It is another object of the invention to provide a spinneret assembly utilized for spinning "islands in sea" type multi-ingredient composite fibers having a very large number of core ingredients dispersed in an intervening ingredient in its cross section.

It is further object of the invention to provide a spinneret assembly utilized for spinning multi-ingredient composite fibers in which at least one core ingredient of "islands in sea" type structure is encircled by a sheath ingredient.

It is a still further object of the invention to provide a spinneret assembly for spinning "islands in sea" type multi-ingredient composite fibers having a very large number of core ingredients in an intervening ingredient, which spinneret assembly is provided with a larger number of nozzle orifices per one spinning pack or one nozzle holder compared to a conventional one and can be easily disassembled to several units and then reassembled therefrom for facilitating overhaul.

The above-mentioned objects are achieved by a spinneret assembly for spinning multi-ingredient composite fibers comprised of at least two kinds of polymer component, which assembly is constituted by a combination of three kinds of spinneret element.

The first kind of spinneret element (a) comprises at least one group of a composite stream forming region in which a composite stream is formed by joining two polymer streams separately guided from each other, a channel for guiding the one polymer stream extending from a source thereof to the composite stream forming region,

and a channel for guiding the other polymer stream extending from a source thereof to the composite stream forming region.

The second kind of spinneret element (b) comprises at least a stationary type dividing device having a function of forming a multi-phase composite stream finely divided along the lengthwise direction thereof by repeated steps of dividing a composite stream, displacing relative positions of the divided streams to each other, and collecting them again.

The third kind of spinneret element (c) comprises a converging portion, in which the multi-phase composite stream obtained from the first or second spinneret element is converged, and a nozzle orifice following the converging portion.

The spinneret assembly may have more than one of each kind of spinneret element (a), (b) and (c) each at a given respective vertical level of the spinneret assembly. The spinneret elements may be arranged in any order provided that the lowermost spinneret element is of the kind (d). The spinneret assembly may additionally include at least one spinneret element not of the kind (a), (b) or (c) above.

Further objects and advantages of the present invention will be understood more clearly by referring to the accompanying drawings, in which:

Figs. 1A through 1P are transverse sectional views of typical composite fibers obtained by using spinneret assemblies according to the present invention;

Figs. 2A and 2B are perspective views of a composite fiber obtained by a spinneret assembly according to the present invention and of a core thereof in larger scale, respectively, illustrating transverse and elevational sections of them;

Fig. 3 is a perspective view of bundles of extremely fine filaments obtained by dissolving an intervening ingredient of the fiber illustrated in Fig. 2A;

Figs. 4A and 4B are transverse sectional views of multi-ingredient polymer streams for better understanding of how a multi-phase composite stream is encircled by a sheath ingredient stream;

Figs. 5 through 8 are elevational sectional views of four spinneret assemblies according to the present invention;

Figs. 9 and 10 are elevational sectional views of part of two spinneret assemblies other than those illustrated in Figs. 5 through 8, in which only one element W is shown;

Figs. 11A and 11B are perspective views of two modified pipes utilized for the spinneret illustrated in Fig. 10;

Figs. 12A and 12B are transverse and elevational sectional views of a modification of part of the element W utilized for a spinneret assembly of the present invention;

Figs. 13A and 13B are similar views as Figs. 12A and 12B for another modification of the element W;

Fig. 14 is an elevational sectional view of a modification of the element W other than those shown in Figs. 5, 6 and 7;

Figs. 15A and 15B are transverse and elevational sectional views of another modification of the element W, respectively;

Figs. 16A and 16B and Figs. 17A and 17B are similar views as Figs. 15A and 15B;

Figs. 18 through 21 are elevational sectional views of part of four further embodiments of the present invention provided with a plurality of nozzle orifices per one dividing device; and

Figs. 22 through 24 are three modifications of combinations of elements Y and Z shown in Fig. 6.

Before describing the mechanism of a spinneret assembly according to the present invention, the structure of resultant fibers from the spinneret assembly and the usage thereof will be explained for better understanding.

First, structures of the fibers from the inventive spinneret are explained referring to Figs. 1A through 1P.

The fibers shown in Figs. 1A through 1D are normally composed of two ingredients and are obtained by a two-stream system. Here, the term "two ingredients" does not always mean two kinds of polymers, because any one ingredient may be composed of two or more kinds of polymers. The fibers shown in Figs. 1E through 1P are usually composed of three ingredients and are obtained by a three-stream system. In this case,too, the term "three ingredients" does not always mean three kinds of polymers. It may include four or more kinds of polymers or, in some cases, only two kinds of polymers. In order to simplify the explanation, however, the fibers of Figs. 1A through 1D are assumed to be composed of two kinds of polymers; and those of Figs. 1E through 1P to be composed of three kinds of polymers.

The fibers of Figs. 1A through 1D are each constituted by a plurality of islands (cores) of a first ingredient 1 and a sea of a second ingredient 2. The fibers of Figs. 1E through 1H are each constituted by a core composed of a plurality of islands of the first ingredient and a sea of the second ingredient 2 and a sheath composed of an ocean of a third ingredient 3. The fibers of Figs. 1I through 1P are each constituted by a plurality of archipelagos composed of a plurality of islands of the first ingredient 1 and a sea of the second ingredient 2 and an ocean of the third ingredient 3.

In these examples, the structure of the combination of the first and second components is obtained by dividing a primary stream of the first ingredient 1 into a plurality of secondary streams of more than 10, in special case more than 100, 1,000 or 10,000 and, by joining the secondary streams with another secondary stream of the second ingredient 2,

whereby the cross section of the fiber takes on the archipelago-like appearance.

The configuration of the island of the first ingredient 1 is usually a circle, especially when the size thereof is relatively small. However, non-circular configurations are also available according to the present invention, such as the spindle shape shown in Fig. 1D, mica shape shown in Fig. 1K, scale shape, new moon shape, polygonal shape, or shape of Celebes Island. Further, as shown in Fig. 1B, some of the cores of the first ingredient 1 may include islands of the second ingredient 2 therein. Also, as shown in Fig. 1M, some of the islands in the archipelago forming a core may be of the similar structure as the case of Fig. 1B. The configuration of the archipelago forming the core is substantially circular when the weight ratio of the archipelago ingredients 1 and 2 divided by the ocean ingredient 3 is rather small. However, as the ratio becomes larger, the shape thereof is deformed, gradually becoming a densely packed condition as shown in Fig. 1L.

The fiber in Fig. 1N is produced by conjugating a resultant ingredient of the archipelago from the first and the second ingredients 1 and 2 with the third ingredient 3 of the ocean.

The fiber in Fig. 10 has a plurality of archipelagos of different sizes.

In Fig. 1P, part of the archipelago ingredient is exposed on outer surface of the fiber.

The composite fiber obtained by the inventive spinneret assembly usually has a circular cross-section but may have other configurations, such as the trilobal shown in Fig. 1C, a polygon, bar, or starfish corresponding to the configurations of nozzle orifices, which can be varied in accordance with the purpose of the final product.

The longitudinal structure of the typical

composite fiber is illustrated in Fig. 2A, in which six cores of the archipelago composed of a plurality of small cores of the first ingredient 1 and a sea of the second ingredient 2 are embedded in an ocean of the third ingredient 3 and extend in the longitudinal direction substantially to form continuous filaments. One core of the composite fiber shown in Fig. 2A is illustrated in Fig. 2B in an enlarged scale. As is apparent from the drawing, the core of the composite fiber according to the invention has a very large number of extremely fine continuous filaments of the first ingredient 1 dispersed in the second ingredient 2.

By dissolving the second and third ingredients 2 and 3, only the first ingredient 1 forming the extremely fine multi-filament can be obtained. The multi-filament thus obtained is composed of six sub-bundles constituted by a large number (10, 100, or more than 1000) of extremely fine filaments.

The fibers obtained by means of the spinneret assembly of the present invention are suitably utilized for making napkins, towels, various microfilters, polishing cloths, wiping cloths, wicks of kerosine room heaters or lamps, artificial blood vessels, artificial skin, gauze, substrates of artificial fur, and so on after being converted to an intermediate product such as yarn, strand, or sheet with part of the ingredients removed by dissolution, if necessary.

Since a compactly woven fabric from the fibers obtained by means of the inventive spinneret assembly allows steam or air to pass therethrough, while stopping water splashes or water drops.

Especially, since the fiber produced by the inventive spinneret assembly is similar to a collagen fiber in structure, the fiber is very advantageously used as material of various artificial leather. By the usage of this fiber, a calf-like leather with a grain

side of favorable hand feeling, a nubuck-like leather densely covered with a plurality of short naps, or a suede-like leather of soft hand feeling as well as elegant appearance is obtained. If the fibers obtained by the inventive spinneret assembly are subjected to high speed fluid flow such as a water jet stream, they can easily be split to a large number of fibrils which are suitable for forming a grain side of the artificial leather. The fibers from the inventive spinneret assembly may impart new features to many other goods, whereby the usages of the fiber will be developed more widely.

To produce the composite fibers shown in Figs. 1A through 1P, the following process 1 or combination of process 1 with 2 or 3 may be basically adopted after forming the multi-phase composite stream of the first and second ingredients 1 and 2 shown in Fig. 4A:

1. discharging the stream directly from a nozzle orifice,

2. encircling the stream with the third ingredient 3 to form a sheath-core stream as shown in Fig. 4B prior to discharging it from the nozzle orifice, and

3. collecting a plurality of the sheath-core streams of Fig. 4B and converging them to form one stream prior to being discharged from the nozzle orifice.

A first spinning process which may be carried out using an apparatus embodying the present invention is more clearly explained referring to a spinneret assembly illustrated in Fig. 5, by which the composite fibers in Figs. 1A through 1D are obtainable.

For better understanding, the spinneret assembly is sectioned into three spinneret elements W, X, and Z in Fig. 5, which are, respectively, examples of constructions of the kinds (a), (b) and (c) generally described above. In element W, a molten polymer of the first ingredient 1 is distributed into a plurality of streams I by holes 4 bored through a first rigid plate a. The streams I sequentially flow down in

holes 5 bored through a second rigid plate b and pipes 7 held in holes bored in a third rigid plate c and reach a funnel-like portion 10. Each stream I is encircled by a stream II of the second ingredient 2 introduced from a space 8 into an annular space between the pipes 7 and holes 9 bored through a fourth rigid plate d. As the annular spaces control the streams II, it is possible to obtain a uniform sheath-core composite stream from every outlet of the hole 9. In this case, the holes 4, 5 and the pipes 7 constitute channels for the polymer streams I, while the space 8 and the holes 9 form channels for the polymer streams II. The sheath-core composite streams are collected in the funnel-like portion 10 before introduction to a dividing device 11. The portion 10 may be of any configuration not limited to a funnel shape provided it can converge a plurality of composite streams.

The holes 4 bored through the first rigid plate a mainly function to divide the molten polymer into a plurality of uniform polymer streams I. The holes 4 are not always necessary because the pipes 7 also have the same distributing function. However, the holes 4 are narrower, particularly at the lowermost portions thereof, which allow the polymer streams I to be distributed more uniformly.

The holes 5 bored through the second rigid plate b serve to communicate the holes 4 to the pipes 7. The holes 5 are also not always necessary, however, are preferable as they prevent the pipes 7 from coming out upward from their secured positions. The pipes 7 are also preferably provided with a stepped portion 6 so as not to fall out downwardly from their secured position. The pipes 7 may be set in the third rigid plate c by means of various methods other than mere insertion as shown in Fig. 5, such as screw engagement, welding, or adhesion. Further, the pipe may be formed integrally

with the third rigid plate c when manufactured.

The space 8 is defined by the third and fourth rigid plates c and d. The polymer stream II is supplied through a suitable route (not shown) to the space 8. Since the holes 9 of the fourth rigid plate d have larger diameters than the outer diameters of the pipes 7, there are provided the annular spaces between the pipes 7 and the holes 9. The polymer streams II are controlled so well by the annular spaces that the polymer streams I can be encircled uniformly within streams II, as stated before.

Next, spinneret element X will be explained. The element X comprises a dividing device 11, the fundamental functions of which are:

(1) dividing the polymer streams I and II along the flowing direction thereof,

(2) displacing relative positions of the divided streams to each other, and

(3) collecting again the divided streams.

The steps are repeated until a plurality of multi--phase polymer streams finely mixed along the flowing direction thereof are formed. The dividing device 11 may be a known stationary type such as "Static Mixer" of Kenicks Co. (U.S.A.), "Square Mixer" of Sakura Seisakusho (Japan), "Honeycomb Mixer" of Tatsumi Kogyo (Japan), "T.K-ROSS ISG Mixer" of Tokushu Kika Kogyo (Japan), or "High Mixer" of Toray Engineering (Japan) (all tradenames). Besides these, a multilayer collecter is known from Japanese Unexamined Patent Publication No. 55-154127. Using stationary type dividing devices, the multilayer of the polymer streams I and II can be repeatedly divided parallel to the lengthwise direction so as to obtain a two dimensional micro-dispersion of the polymer in the form of a substantially infinite number of streaks.

In Fig. 5, the finely divided and mixed streams thus obtained are directly introduced into a

funnel-like converging portion 12. Prior to this, the streams may be passed through a micro-porous layer such as a metal net, sand layer, sintered metal sheet, or honeycomb layer.

The number of units of the dividing device 11 is optional. However, one or two is too few to obtain extremely fine filaments because the number of the cores in the resultant multi-ingredient fiber becomes too small. The spinneret assembly illustrated in Fig. 5 has eight dividing units. The dividing units may be arranged to form a single or a plurality of parallel polymer stream passages. It is not necessary that all the units be of the same type.

Regarding element Z, the polymer streams finely divided by the dividing device 11 are converged by passing through the converging portion 12 and discharged from a nozzle orifice 13 to form a filament fiber. The cross-section of the orifice 13 is usually circular, however it may be any configuration such as Y, T, L, -, +, * or ☉, in accordance with need.

The spinneret assembly of Fig. 5 is one embodiment of the present invention. There are, however, other variations in a spinneret assembly of the present invention Namely, the number of the elements W, X, and Z and the order of arrangement can be changed optionally.

An example, by which the multi-ingredient composite fibers shown in Figs. 1E through 1H are obtained, is illustrated in Fig. 6. For better understanding, the spinneret assembly is sectioned into four elements designated as W, X, Y, and Z. In this case, the elements W and X are substantially identical to those of Fig. 5 and, accordingly, are not explained here again. The polymer streams finely divided by the dividing device 11 are introduced to a funnel-like portion 14 and then flow down through a pipe 16 to a converging portion 20. Prior to reaching the converging portion 20, the finely divided streams (to

form a core) are encircled by a polymer stream III (to form a sheath) introduced from a space 17 to an annular space between the pipe 16 and a hole 18. That is, the polymer stream III uniformly flows down through the annular space around the pipe 16 and covers the stream of the core ingredient flowing down through the pipe 16 at a joining point 19 of the streams, thereby forming a sheath-core type composite streams. As stated above, in the element Y, the funnel-like portion 14 and the pipe 16 constitute a channel for the composite core ingredient, while the space 17 and the hole 18 constitute a channel for the sheath ingredient. The funnel-like portion 14 is not always necessary when the inner diameter of the pipe 16 is equal to or somewhat larger than that of the outlet of the dividing device 11. Contrary to this, when the inner diameter of the pipe 16 is considerably larger than that of the outlet of the dividing device 11, the portion 14 is preferably of a trumpet shape.

In element Z, the sheath-core type composite stream thus formed is converged while passing through the converging portion 20 and is discharged from a nozzle orifice 21 as a single filament.

The pipe 16 set in a rigid plate preferably has a stepped portion 15 so as not to fall out downward from its secured position. The pipe 16 may be set in the rigid plate by means of various methods other than mere insertion as shown in Fig. 6, such as screw engagement, welding or adhesion. Further, the pipe may be formed integrally with the rigid plate when manufactured.

It will be apparent from the above explanation that the elements W and Y of the spinneret assembly in Fig. 6 are of a similar structure though the number of channels for the polymer stream are different. In other words, the spinneret assembly of Fig. 6 can also be described as having spinneret elements of the kind W-X-W-Z in that order.

Figure 7 illustrates a modification of the

spinneret assembly of Fig. 6, in which lower element W corresponding to element Y in Fig. 6 is adapted to have a plurality of channels for the polymer stream and by which the multi-ingredient composite fibers shown in Figs. 1I through 1P can be obtained. In this spinneret assembly, the polymer stream finely divided and mixed by the dividing device 11 is branched to a plurality of secondary streams in lower element W which is disposed beneath element X. In the lower element W, the secondary streams are joined with polymer streams III to form a plurality of a sheath-core structure. Then, in element Z, they are collected and converged through a funnel-like portion 28 and finally are discharged from a nozzle orifice 29 as a single filament fiber. Similar to that in Fig. 6, the spinneret assembly in Fig. 7 can be represented as W-X-W-Z.

Figure 8 illustrates another modification in which the spinneret elements are connected in the order of X, W, and Z. The modified spinneret assembly produces the same kinds of multi-ingredient composite fibers as those obtained by the spinneret assembly in Fig. 7. In this modification, polymer streams I and II, which are fed through separate routes from each other, are joined together at an inlet 30 of the dividing device 11 before introduction thereinto. Of course, the joining point does not always have to be the inlet 30, but may be more upstream. The structures subsequent to the dividing device 11 are substantially identical to those shown in Fig. 7.

The parts of the spinneret assembly according to the present invention are not limited to those shown above and may be varied. In element W shown in Fig. 5, at least some of the pipes 7 may be replaced by pipes 31 shown in Fig. 9, each of which has an aperture 32 in the peripheral wall thereof. The polymer stream II is passed into a pipe 31 through an aperture 32 and conjugated with the polymer stream I

portion 10 to form a sheath-core configuration.

It will be understood that the function of element W is to form a composite stream by encircling or conjugating one polymer stream with another polymer stream.

In the case of the spinneret assembly shown in Fig. 8, a two-phase composite stream in which one polymer stream is merely conjugated to another polymer stream is introduced in the dividing device 11. The stream output from the dividing device 11 has a tendency to be a flow of mica-like configuration having a plurality of alternate layers of the polymer streams I and II therein. This tendency is not desirable if one wishes to have extremely fine filaments secondarily from the resultant fibers obtained by the spinneret assembly. In order to obtain such extremely fine filaments one polymer stream has to be dispersed uniformly to present a streak-like configuration in another polymer stream. Thus, in this case, an auxiliary dividing means such as a metal net, sand layer, porous sheet of sintered metal, or porous layer of honeycomb structure is preferably utilized following the dividing device for improving the mica-like configuration of the resultant stream. Using element W in Figs. 5, 6, and 7, the streak-like configuration can be obtained in the resultant stream output from the dividing device 11 without such an auxiliary dividing means; however, provision of such a means further improves the stream structure.

As the number of channels in element W disposed above the element X increases, the extremely fine filament fibers of thinner thickness can be obtained from the resultant fibers. The number of channels should be more than five, preferably more than 10. The dividing and mixing degree of the composite stream at the outlet of the dividing device 11 is improved by

increasing the number of channels in element W disposed above the element X or units of the dividing device 11. However, for enhancing a stable spinning operation, it is preferable to decrease the number of units of dividing device 11 in element X and to increase the channels in element W.

Figures 18, 19, 20, and 21 illustrate other spinneret assemblies according to the present invention, which have a combination of one dividing device to a plurality of nozzle orifices. Spinneret assemblies having two or more of the above combinations parallelly arranged are also included within the scope of the present invention. The spinneret assembly shown in Fig. 21 is further provided with an auxiliary dividing means comprising a metal net 46 and a sand layer 47 between a dividing device 11 and a group of the nozzle orifices. Reference numeral 48 designates a housing of a spinning pack.

The inventive spinneret assembly may have a plurality of pairs of one dividing device and one nozzle orifice parallelly arranged to each other.

Element Y in Fig. 6 utilized for forming a sheath-core type composite stream may be replaced by those shown in Figs. 10, 22, 23, and 24.

In the present invention, the cross-sectional configurations of the holes, pipes, and funnel-like portions are preferably circular but can be selected to be a configuration other than a circle in accordance with the need. This also holds true for the diameters of the holes and the pipes.

The spinneret assembly according to the present invention consists of one or more rigid plates. The number of the plates should be decided in view of easy manufacturing and cleaning. The spinneret assemblies shown in the drawings are all assembled with a suitable number of rigid plates.

The overall configuration of the assembly may be

for example, of a cylinder or a square-section column.

Various materials may be utilized for the rigid plates, such as stainless steel (SUS-304, 316, or 630), iron, titanium, chrome steel, tungsten steel, molybdenum steel, glass, quartz, ceramic, gold, platinum, or specially provided plastic or any combination of the same.

The spinneret assembly according to the present invention can be utilized for melt spinning (including spinning of extremely large thickness filament such as gut, in which the resultant filament is directly quenched by water just after spinning), dry spinning, or wet spinning. Further, all known polymers having fiber-forming ability can be processed by the spinneret assembly. Various additives may be added in the polymer if necessary.

The resultant fibers from the inventive spinneret assembly may be drawn several times in length if necessary for adjustment of strength or residual elongation, or subjected to false twisting or heat treatment so as to be converted to textured yarns if necessary. Thereafter, they may be processed to be woven or knitted fabrics or non-woven fabrics and subjected to many other known treatment such as resin treatment, dissolution of ingredients, coating, or dyeing.

The inventive spinneret assembly may be utilized not only for the fiber production described hereinbefore but also for production of other moldings. For example, film may be obtained by modification of the orifice configuration.

CLAIMS:-

1. A spinneret assembly for spinning multi-ingredient composite fibers comprised of at least two kinds of polymer phases, which assembly comprises, in combination:

at least one spinneret element (a), the or each spinneret element (a) comprising at least one of a combination of a composite stream forming region in which a composite stream is formed by joining two polymer streams separately guided from each other, a channel for guiding the one polymer stream extending from a source thereof to said composite stream forming region, and a channel for guiding the other polymer stream extending from a source thereof to said composite stream forming region;

at least one spinneret element (b), the or each spinneret element (b) comprising at least one stationary dividing device having a function of forming a multi-phase composite stream finely divided along the lengthwise direction thereof by repeated steps of dividing a composite stream with sub-streams spaced apart from each other, and collecting the sub-streams again; and

at least one spinneret element (c), the or each spinneret element (c) comprising at least one converging portion in which the multi-phase composite stream obtained from said spinneret element (a) or (b) is converged, and a nozzle orifice following the or each said converging portion;

the number and order of arrangement of the said spinneret elements (a) and (b) being optionally selected and the or a said spinneret element (c) being disposed at the lowermost position of said spinneret assembly.

2. A spinneret assembly according to claim 1, in which the order of arrangement of said spinneret elements is (a)-(b)-(c).

3. A spinneret assembly according to claim 1, in which the order of arrangement of said spinneret elements is (a)-(b)-(a)-(c).

4. A spinneret assembly according to claim 1, in which an order of arrangement of said spinneret elements is (b)-(a)-(c).

5. A spinneret assembly according to claim 3, in which the uppermost said spinneret element (a) comprises one of a combination of said channel for the one polymer stream, said channel for the other polymer stream and said composite stream forming region.

6. A spinneret assembly according to claim 3 or 5, in which the lowermost said spinneret element (a) comprises one of a combination of said channel for the one polymer stream, said channel for the other polymer stream and said composite stream forming region.

7. A spinneret assembly according to claim 2, further comprising an auxiliary dividing means for more finely dividing said composite stream disposed between said spinneret elements (a) and (b).

8. A spinneret assembly according to claim 4, further comprising an auxiliary dividing means for more finely dividing said composite stream disposed between said spinneret elements (b) and (a).

9. A spinneret assembly according to claim 7 or 8, in which said auxiliary dividing means is a sand layer.

10. A spinneret assembly according to any one of the preceding claims, in which part of said channel for the one polymer stream in said spinneret element (a) is a pipe provided with a plurality of dents or apertures for allowing the other polymer stream to flow into said pipe.

11. A spinneret assembly according to any one of claims 1 to 9, in which part of said channel for the one polymer stream is a pipe inserted into a hole, an inner surface of said hole defining an annular section space constituting part of said channel for the other polymer stream in association with an

outer surface of said pipe, which annular space has a constricted part.

12. A spinneret assembly according to claim 1, in which a plurality of said converging portions and nozzle orifices are provided in said spinneret element (c).

Fig.1A

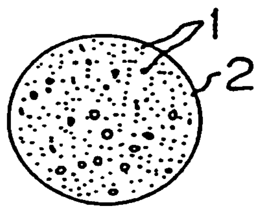


Fig.1B

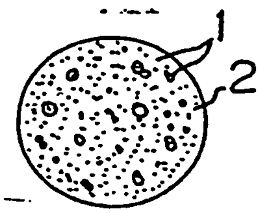


Fig.1C

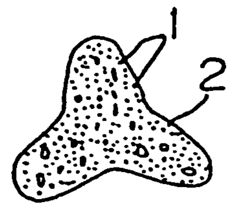


Fig.1D

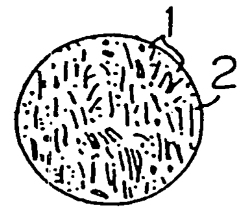


Fig.1E

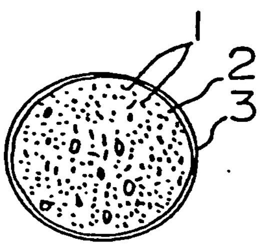


Fig.1F

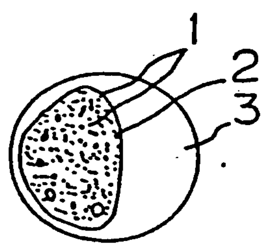


Fig.1G

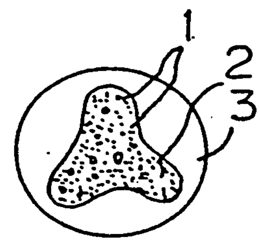


Fig.1H

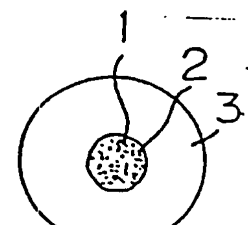


Fig.1I

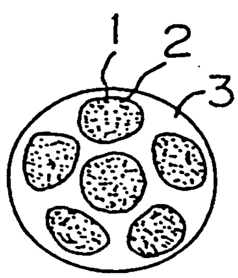


Fig.1J

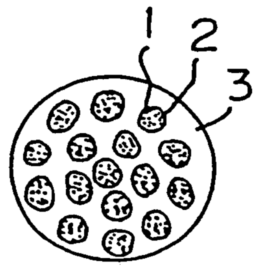


Fig.1K

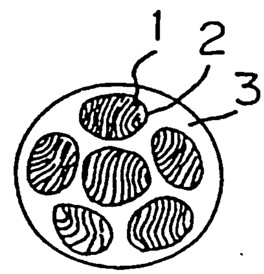


Fig.1L

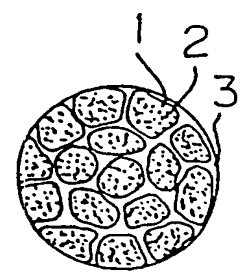


Fig.1M

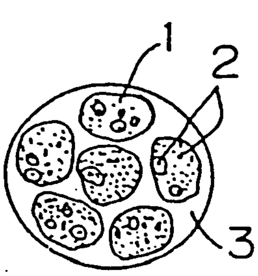


Fig.1N

Fig.1O

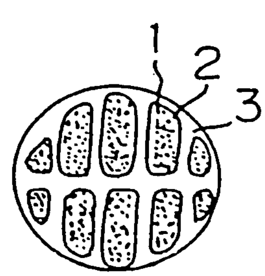


Fig.1P

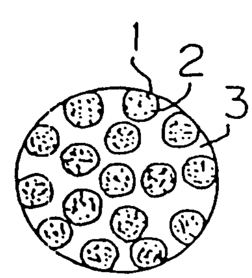


Fig. 2A

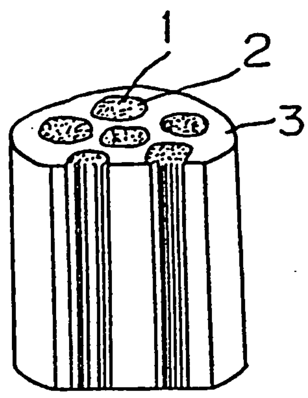


Fig. 2B

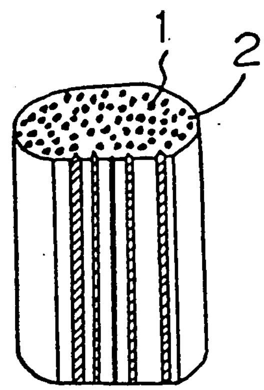


Fig. 3

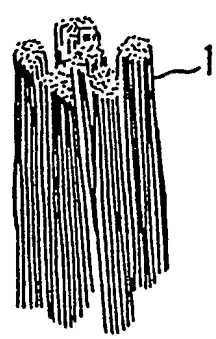


Fig. 4A

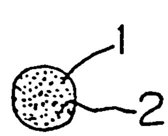


Fig. 4B

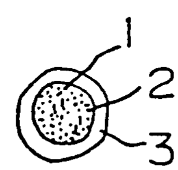


Fig. 5

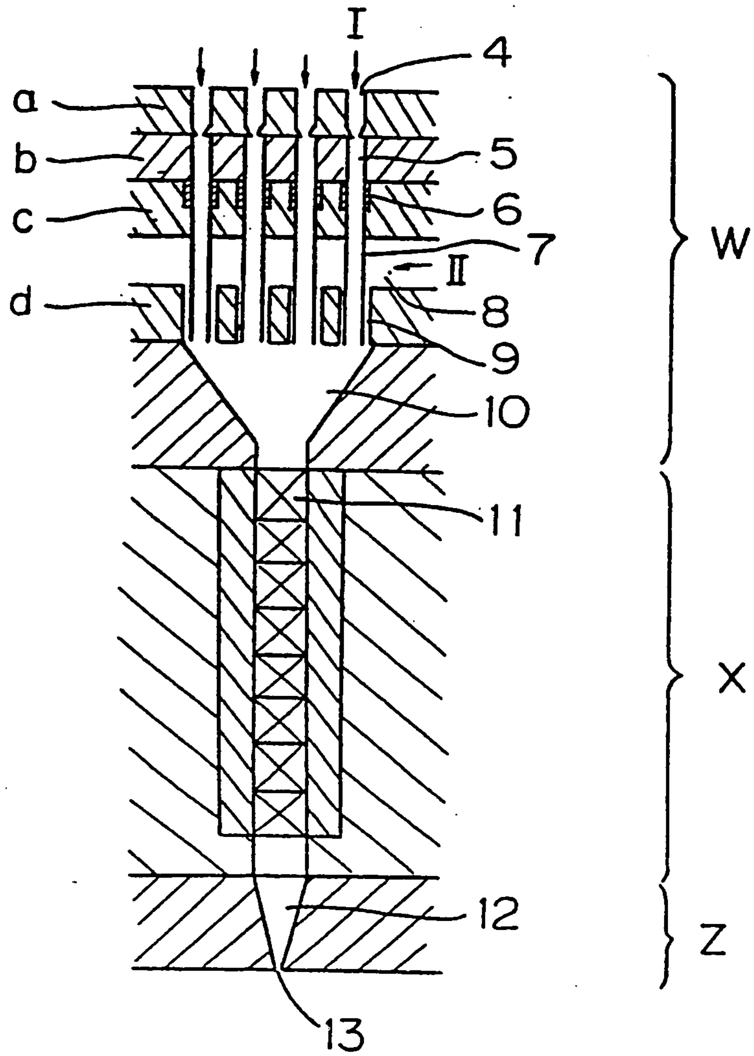


Fig. 6

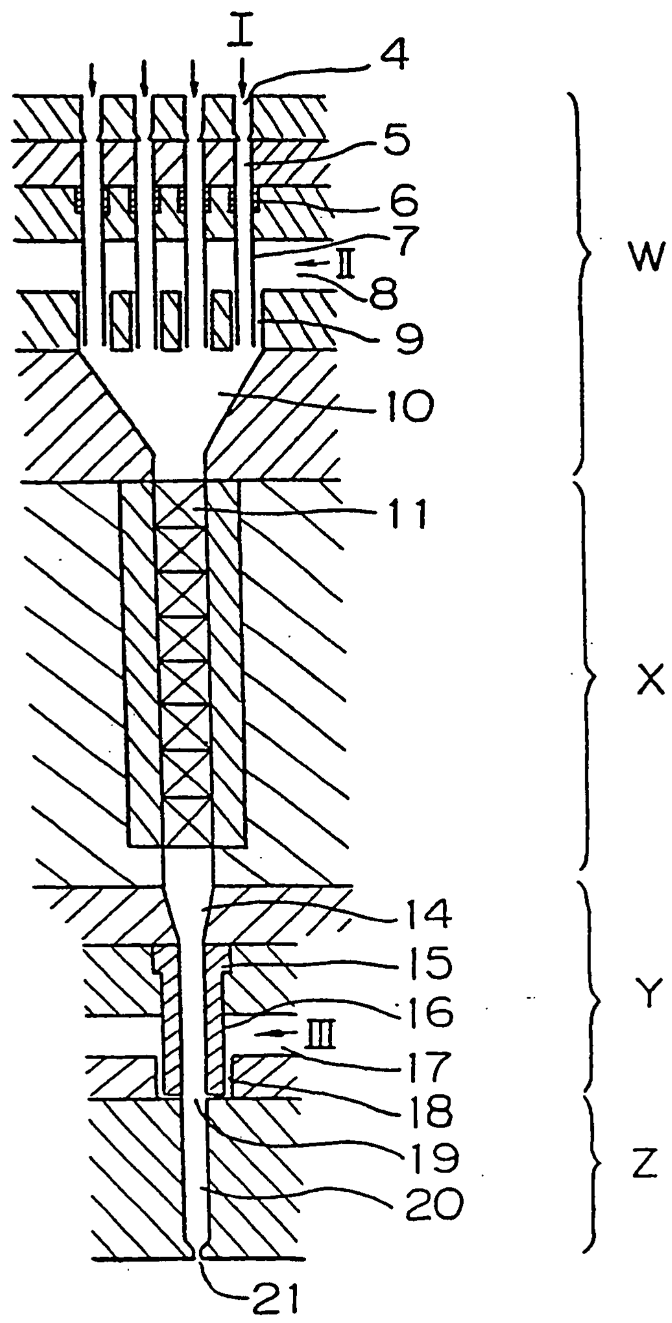


Fig. 18

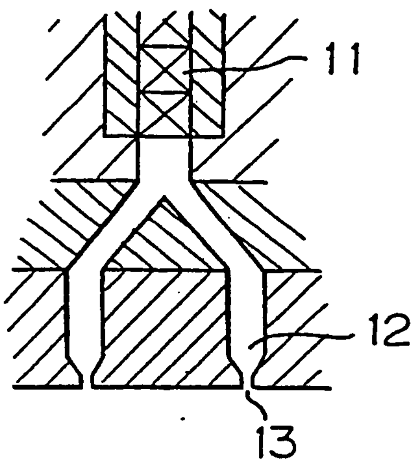


Fig. 19

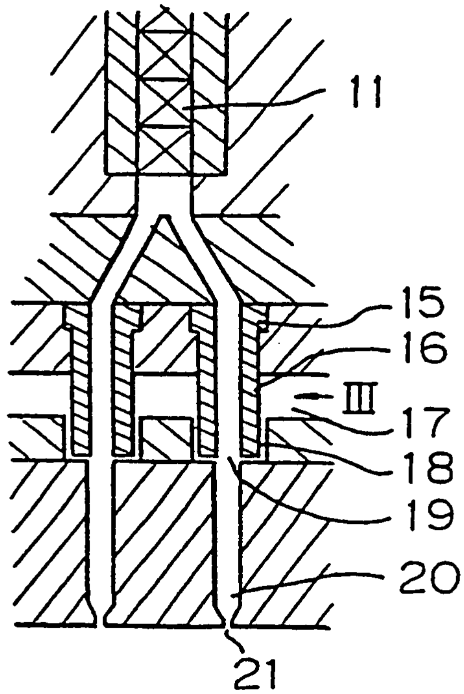


Fig. 22

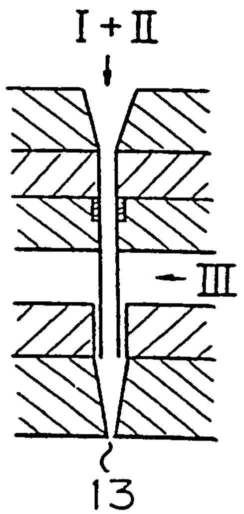


Fig. 23

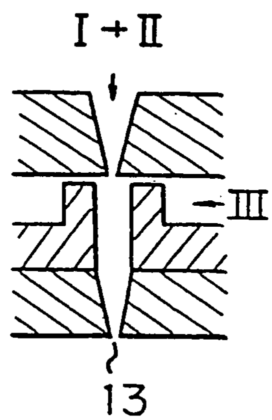


Fig. 24

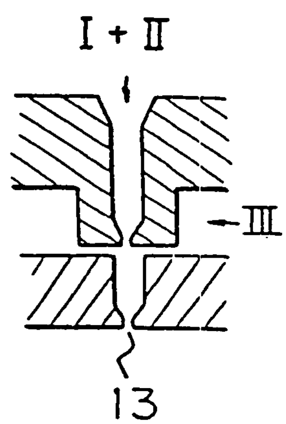
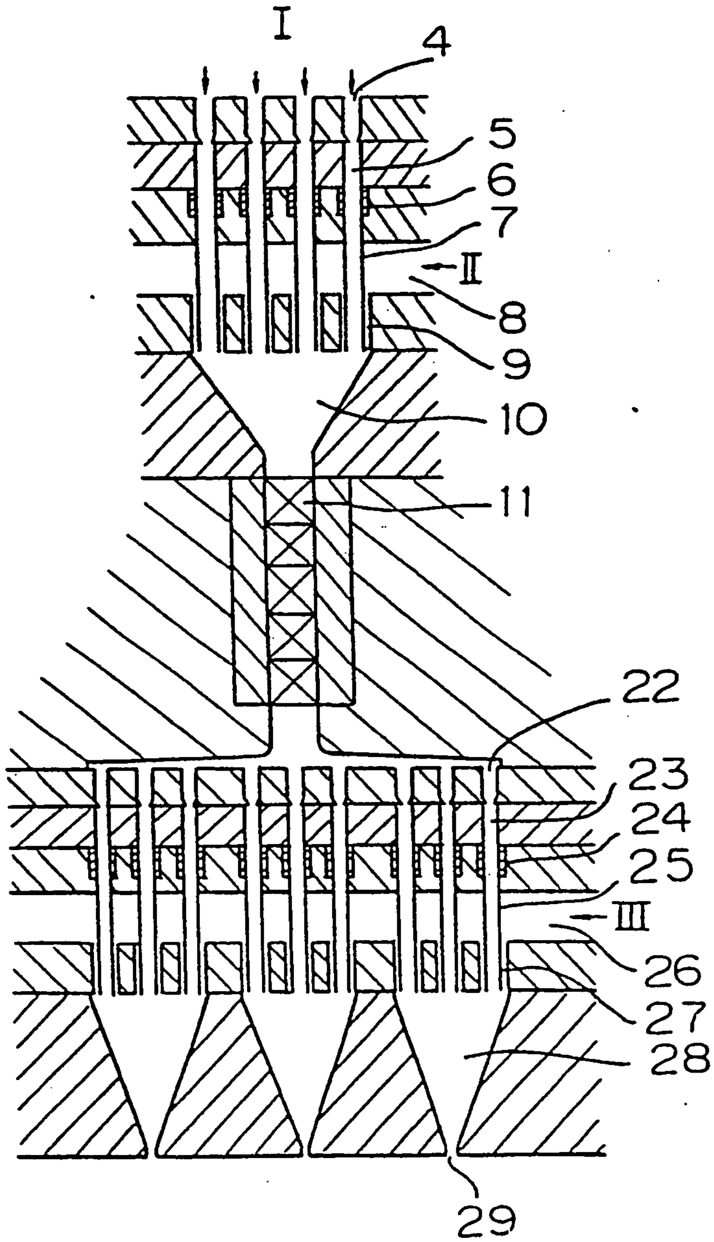


Fig. 20



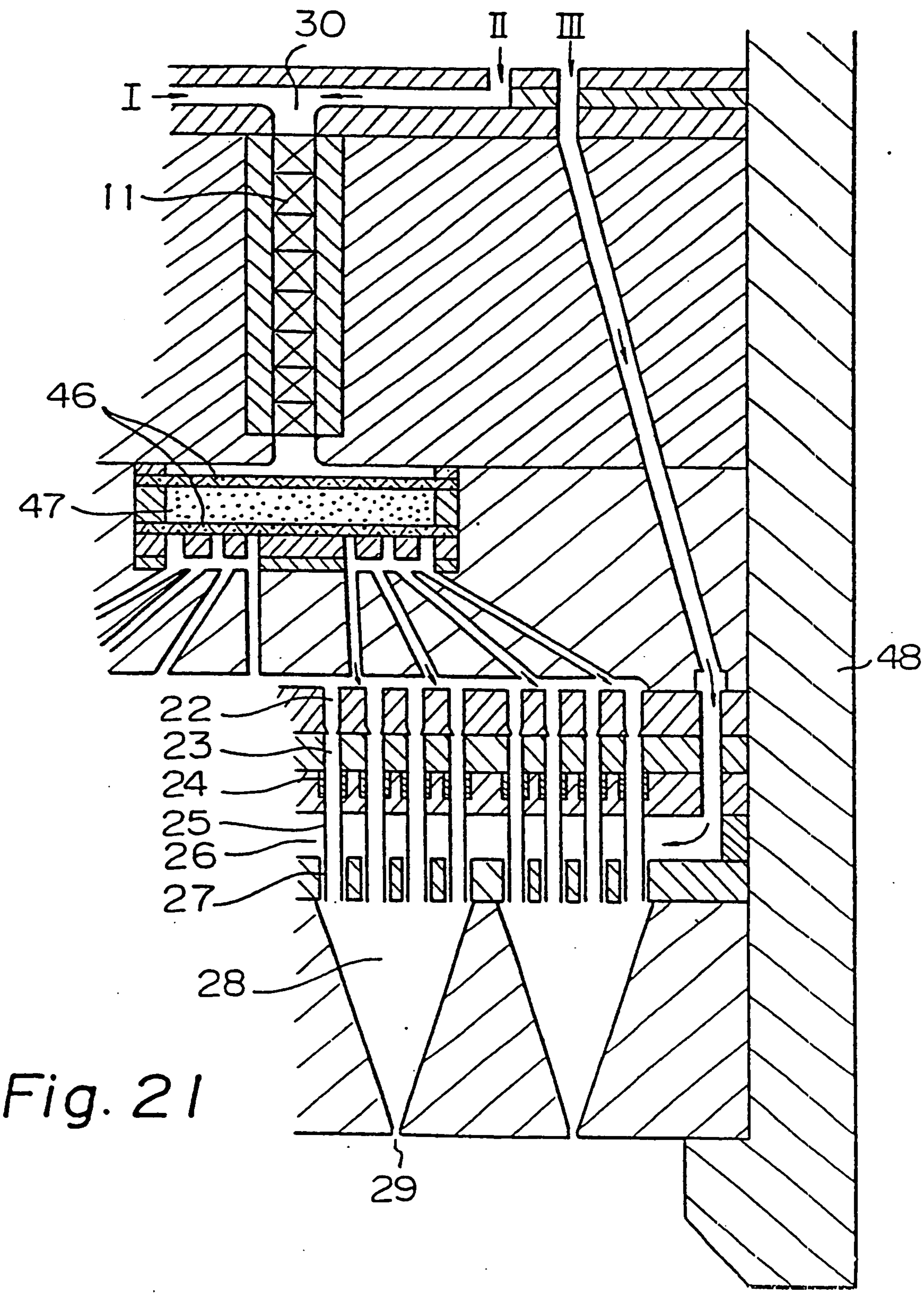


Fig. 21